

LXIX. *Observations of the Transit of Venus over the Sun, June 3, 1769; made by Mr. Owen Biddle and Mr. Joel Bayley, at Lewestown, in Pennsylvania. Communicated by Benjamin Franklin, L.L.D. F.R.S.*

Read Dec. 21, 1769. On the 26th of May, 1769, Joel Bayly and myself arrived at Lewestown (on Cape Hinlopen at the mouth of Delaware Bay), being ordered there, by the American Philosophical Society, held at Philadelphia, for promoting useful knowledge, to take an observation of the ensuing transit of Venus over the Sun's disc; and immediately set about fixing our time-piece, in a house (which we hired) on the south street of the town, where we were most likely to be free from interruption, and had an open view of the Sun and stars for our observations. We set a strong oak post in the ground, to which we screwed our clock case, resting the base of it on the ground, the face of it fronting a door which opens to the southward, so as to be convenient for us to hear the beat of the clock, where we intended to fix our telescopes and instrument for taking equal altitudes. We then set a post in the ground for the equal altitude instrument, which was not

not so good as I wished, but much better than a Hadley's quadrant, as we found by experience, and the best we could procure in time for our purpose. It was a theodolite, with telescopic sights, in which there were cross hairs; it had a spirit level to adjust the plain of the instrument horizontally; and also one applied to the telescope parallel with its axis, and at right angles to the other spirit level. By means of these two levels and adjusting screws, we found we could adjust it very nearly, the instrument being a very good one of the kind. With this we set our clock, by taking equal altitudes of the Sun, which we corrected by the tables published in a pamphlet, intitled, *Instructions relative to the ensuing Transit of Venus, &c.* by the Rev. Mr. Nevil Maskelyne. The 27th, we got some good corresponding altitudes of the Sun, by which we set our clock; and took equal altitudes of some of the fixed stars, to prove the rate of our clock. After this it continued cloudy, with rain at times, and a high wind at north-east, till the 31st, when the clouds broke a little. During this time, we employed ourselves in measuring the distance of our place of observation from the stone fixed at the beginning, or east end, of the east and west line, which is the boundary between the three lower counties and Maryland, and is situate on Fenwick's Island; the latitude and longitude of this place being accurately determined by Messieurs Dixon and Mason.

The meridional difference of the latitude of the place of our observation, north from Fenwick's Island, at the beginning of the east and west line, as before described, being the easternmost end of the southern boundary

boundary between the lower counties and Maryland, is $19' 41'' 24'''$; and the meridional difference of longitude of the place of our observation, west from the point aforesaid, in Fenwick's Island, $5' 45''$ of a degree. These data, with the latitude and longitude of Station Point, will determine exactly the place of observation.

June 2, the weather being clear, had good corresponding observations of the Sun.

June 3, the weather being remarkably fine, had good observations to set our clock. About 12 o'clock began to direct our glasses to the Sun, keeping it continually in the field from then to the time the observation was past. We agreed to watch our telescope one minute in turn, till about seven or eight minutes before the contact was expected, lest, by too steady an attention to the glasses, our sight should be impaired, so as to disable us from discerning the contact clearly. I had left my telescope the minute preceding the contact, intending to apply myself steadily to it, from the next minute, until the observation was past; and when the 48th second was called, I applied myself to the glass, and by the time three seconds were elapsed, I perceived, on that part of the Sun's limb where I expected the contact, a small impression, which proved to be the limb of Venus in contact with the Sun. All the limb of the Sun, which appeared at that time in the field of the telescope, had a small undulatory motion, which, I apprehend, was owing to dense vapours, which arose at that place, being near the sea. At Venus's first appearance to me, it was only like one of those waves on the limb or border of the Sun, increased in

so small a proportion, that I remained doubtful for several seconds, whether it was any thing else ; thus it continued, making a deeper impression, with that tremulous motion, for about ten seconds, when the tremor where Venus was in contact ceased, and the indenture was truly circular, with an even termination.

My absence from the telescope, just before the contact occurred, deprived me of an opportunity of judging whether there was any appearance of an atmosphere preceding the western limb of Venus in contact ; but when Venus had entered nearly one half of its diameter into the Sun's disc, my companion and myself saw a luminous crescent, which enlightened that part of Venus's circumference which was off the Sun, so that the whole of her circumference was visible, but did not continue so until the internal contact ; and at the time of the first internal contact, the eastern or external limb of Venus seemed to be united to the Sun's limb by a black protuberance or ligament, which was not broke by the entrance of the thread of light, till four seconds after that the regular circumference of Venus seemed to coincide with the Sun's.

The telescope I made use of for viewing the transit, was a reflecting one, belonging to the Philadelphia Library Company, the speculums of which are $2\frac{1}{2}$ feet apart, and the lenses in the eye tube four inches apart ; it was the least magnifying power that I used, as I found the tremulous motion too much magnified by the other power. The small one was in good order, and defined the Sun's limb, and spots on its disc, very clearly. I had applied a polar axis

to it, and made some rack-work, by which I could keep the same part of the Sun's limb in the field with ease ; my companion was not so well provided with a telescope, the one he used being of Dollond's refracting glasses of $4\frac{1}{2}$ feet. This we fixed, with a ball and socket, to a post, by which it was easily directed to the Sun. Thus furnished, we found the contacts to take place as follows, reduced to mean time.

	h	m	s
Owen Biddle's External contact at	2	11	53
Internal one at	2	29	53
Joel Bayley's External contact was } lost by an accident, but seen by him, } after it had taken place, at } Internal ditto	2	12	15
		29	53

It must be noted, the internal contact, given by Owen Biddle, is at four seconds before the thread of light had broken the dark ligament or protuberance, by which Venus's limb was united to the limb of the Sun, that being the time he estimated the two limbs to be in contact.

The internal contacts, we think, may be relied on ; the external happening sooner than expected, occasioned a doubt at its appearance, which made the exact second of its appearance a little uncertain.

Signed,

Philadelphia,
June 9, 1769.

Owen Biddle.

Copy taken in haste, but the times examined by
Owen Biddle.

The

The times of the contacts of Venus with the limb of the Sun, as seen by Owen Biddle and Joel Bayley on Cape Hinlopen; with the true difference of latitude and departure of the place of their observation, from the Middle Point between Fenwick's Island and Chesopeak Bay, are as follows, viz.

	h	m	s	
External contact at	2	11	53	} mean time
Internal contact at	2	29	53	

The difference of latitude of the place of observation, north of } 21,93 miles
Middle Point.

The meridian distance of the place of observation, east of } 30,6356 miles
Middle Point.

The latitude and longitude of Middle Point were taken by Messieurs Dixon and Mason, and, as we suppose, communicated to the Royal Society, but we are not yet acquainted with it.

N. B. As we are not acquainted with the exact measure of a degree of latitude, agreeable to the above gentlemen's measurement, we have sent the difference of latitude and longitude in miles and decimal parts, as it may be reduced to greater certainty thereby.

Remarks by the ASTRONOMER ROYAL.

From the data given above, and the length of a degree of latitude, found by Messieurs Mason and Dixon, in these parts = 68,896 English miles, the difference of latitude of Lewestown and the Middle Point above mentioned (which is the same with the point A; see Messieurs Mason's and Dixon's measure of a degree, Philos. Transact. vol. LVIII. p. 276) is $19' 53''$; but the latitude of the point A was found, by Messieurs Mason and Dixon $38^{\circ} 27' 34''$; therefore that of Lewestown is $38^{\circ} 47' 27''$ north; and the difference of its meridian, and that of the point A, or their difference of longitude, is $34' 0'' = 2' 16''$ of time, Lewestown being to the east. But if the difference of longitude of Lewestown east of the Stones on Fenwick's Isle be supposed truly given, in the former account, $5' 45''$ of a degree, then the difference of longitude of Lewestown and the point A will come out about $1'$ of a degree, or $4''$ of time less; for Mr. Dixon acquaints me, that the distance of the Stone on Fenwick's Isle, east of the point A, is 35 English miles wanting 100 yards. Now this is equal to $30' 26''$ of a great circle = $38' 51''$ of longitude; from which subtracting $5' 45''$, there remain $33' 6''$ for difference of longitude of Lewestown and Point A = $2' 12'' \frac{1}{2}$ of time, or $3'' \frac{1}{2}$ less than found before; and this latter I take to be nearest the truth. If this be so, Lewestown is very nearly under the same meridian with the southernmost part of the city of Philadelphia, or more accurately $13''$ of longitude, answering

answering to $1''$ of time, east of it. For, by Messieurs Maçon's and Dixon's measure of a degree, the point N (see Philos. Transact. Vol. LVIII. p. 276) is $2' 19''$ of longitude west of the point A; and N, by measurement, is 31 English miles due west of the southernmost part of the city of Philadelphia, answering to $35' 12''$ of longitude; from which subtracting $2' 19''$, there remain $32' 53''$, answering to $2' 11''\frac{1}{2}$ of time, for the difference of longitude of the southernmost part of Philadelphia, east of the point A. But Lewestown is found above to be $33' 6''$ of longitude $= 2' 12''\frac{1}{2}$ east of the point A, and consequently is $13''$ of longitude, or about $1''$ of time east of the southernmost part of the city of Philadelphia.

Nevil Maskelyne.